Commonwealth Energy Biogas/PV Mini-Grid Renewable Resources Program

Making Renewables Part of an Affordable and Diverse Electric System in California

Contract No. 500-00-036

Project Prioritization

Project No. 1.1 Program Planning and Analysis

Task 1.1.10 Draft Report

Prepared For:
California Energy Commission
Public Interest Energy Research Renewable Program

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:

- Buildings' End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research

For more information on the PIER Program, please visit the Commission's Web site at: http://www.energy.ca.gov/research/index.html or contact the Commission's Publications Unit at 916-654-5200.

For Commonwealth Program-specific information, please visit http://www.pierminigrid.org.

What follows is a report for the **California Energy Commission, Public Interest Energy Research Program, Contract Number 500-00-036,** conducted by the **Commonwealth Energy Team**. The report is entitled Prioritization Report. This project contributes to the **Renewable Energy** component of the PIER program.

Executive Summary

An important element of the Commonwealth PIER Renewables Mini-grid Program is to identify candidate demonstration projects within the mini-grid study area that advance the understanding of the use of biogas and solar photovoltaics to reduce the need for improvements to the existing study area electrical power distribution system. This report provides the background information and technical basis for site selection and prioritization of the renewable energy projects that may be implemented under the Commonwealth Program.

Key Observations

Several key observations from the prior Project 1.1 task work are:

- There are no landfills within the mini-grid study area for possible hosting of a landfill bioreactor demonstration project. Of the two landfills in the study area, one is closed and the other is expected to close in 2006. As a result, a landfill bioreactor site will be outside of the mini-grid area.
- There are 11 sewage treatment plants within the mini-grid study area. Inland Empire Utilities Agency (IEUA), the owner/operator of 4 of those plants, has been particularly interested in the use of biogas to meet its energy needs. At two of its facilities, Regional Plant 1 (RP-1) and Regional Plant 5 (RP-5), IEUA is operating dairy manure digesters. At RP-5, IEUA has also taken initial steps toward co-digestion of food waste with the manure.
- There is a high degree of interest by Riverside in hosting demonstration projects at its Riverside Regional Water Quality Control Plant. The conventional mesophilic process can be expected to see greater benefit from the demonstration of thermal hydrolysis or ultrasound that the acid phased digestion process used by IEUA at its plants.
- The Chino Basin contains a very high concentration of dairies and dairy cows, almost 300,000 animal units in 2001. A mature dairy cow is equivalent to 1.4 animal units. The number of animal units is expected to decrease by 50 percent by 2015 as a result of the increased residential and commercial development in the Basin.
- For most individual dairies in the Chino Basin it is uncertain as to how development pressures will affect their long term future. Further, onsite waste digestion and the use of biogas to produce electricity are at too small a scale to be of interest or to be cost-effective. Our conclusion is that centralized treatment is more appropriate wherein the waste from a number of dairies is collected and treated, whether through anaerobic digestion or other method.
- There are an estimated 240 existing public sector facilities within the Chino mini-grid study area with an estimated 584,000 square feet of available area for installing building integrated PV systems. These public sector facilities have a technical potential of 21 MW

of amorphous PV generation capacity and 42 MW of crystalline PV generation capacity. This technical potential is expected to grow nearly 24% by 2012.

Prioritized Sites for Biogas

Based on our work to date and the application of the selection criteria as discussed in this report, our prioritized list of leading biogas project sites includes:

1. San Bernardino County's San Timoteo Landfill for a bioreactor demonstration project.
2. IEUA's RP-5 dairy manure digester facility for dairy waste to energy demonstration projects. Projects that could be accomplished at this site include:
    a. Improved digester mixing
    b. Thermophilic digestion
    c. Co-digestion of dairy manure with food processing waste
    d. Improved cellulose destruction
    e. Ultrasound for enhanced digestion
    f. Improved dewatering and waste liquid treatment
    g. Improved gas cleaning
    h. Feedstock pretreatment
3. City of Riverside's Riverside Water Quality Control Plant for ultrasound and/or thermal hydrolysis of waste activated sludge at sewage treatment plants
4. IEUA 's RP-1 for micro-turbines and improved gas cleaning technology
5. San Bernardino County's Mid Valley Landfill for a bioreactor demonstration project.
6. IEUA RP-1 and RP-5 for increased efficiency through waste heat recovery (bottoming cycletechnologies)
7. Badlands Landfill for a bioreactor demonstration project.
8. El Sobrante Landfill for a bioreactor demonstration project.
9. Burrtec Facility for manure digestion or gasification.

As discussed below, this prioritization order is based on technical site suitability for demonstrating potential technologies and qualitative assessment based on a number of other criteria. The prioritization may evolve as additional work is done on specific technologies and locations.

Prioritized Sites for Building Integrated PV

The following list of leading BI-PV sites represents the work to date based on the selection criteria described in this report.

1. Ontario School District for a rooftop installed array in Ontario
2. U.S. Navy Facility for a stand alone dual-use solar-thermal-electric system in Norco

3. CA Institute for Women for a rooftop installed array in Chino
4. FEDCO for an awning installed array in Ontario
5. IEUA (formerly IKEA) for a rooftop installed array in Rancho Cucamonga
6. Civil Air Patrol for a rooftop installed array in Chino
7. Ranch View Elem. School for a rooftop installed array in Mountain View
8. SB Co. Maintenance for an awning installed array at Chino Airport
9. Riverside Comm. College for an awning and rooftop installed arrays in Norco
10. YMCA for an awning installed array in Chino Valley

This prioritization order is based on the existence of a "host facility champion" and the technical suitability of these sites as well as several other qualitative criteria. The process involved the scoring and weighting of each criterion is described in Section 6.3 of this report.

SECTION 1

Introduction

In June 2001, the Commonwealth Energy Team was awarded a programmatic contract under the California Energy Commission's Public Interest Energy Research (PIER) Program to conduct research on strategies for making renewable energy more affordable in California. The Commonwealth Energy approach involves assessing the combined potential of biogas and photovoltaic (PV) resources in a defined study area and identifying how these resources could be developed in a complementary and cost-effective manner. The Commonwealth Energy Team conducted this research in a real world setting so that the findings could be applied elsewhere in California and thereby benefit more California ratepayers. The local area Commonwealth Energy selected for its renewable energy research activities is the Chino Basin, referred to in this report as the "study area."

1.1 Background

The Chino Basin is rich in PV and biogas resources. Moreover, it is a rapidly growing area with substantial and increasing electrical loads. The underlying goal of the Commonwealth Energy PIER Renewables Mini-grid Program is to identify potential Building Integrated PV (BIPV) and biogas energy projects, bring innovative technologies and business practices to these projects, assess the benefit to the local electricity distribution system (the "mini-grid"), and then use the findings to develop a business model for siting cost-effective, renewable energy projects. A description of the Commonwealth Energy PIER Program, including the results of some of the work undertaken to date, is presented in the project Web site, http://www.pierminigrid.org.

An important element of the Commonwealth PIER Renewables Mini-grid Program is to identify candidate demonstration projects within the mini-grid study area that advance the understanding of the use of biogas to reduce the need for improvements to the existing study area electrical power distribution system.

The work summarized in this report is the culmination of the Landfill Database Development, the Sewage Treatment Plant Database, the Agricultural and Food Processing Waste Database, solar PV Nonresidential Market Assessment, determination of the study area mini-grid based on the existing electrical distribution system, and extensive discussions with IEUA, various technology vendors, and potential demonstration project hosts.

1.2 Overview of Project 1.1—Program Planning and Analysis

The primary objectives of the Commonwealth PIER Program are to:

- Determine the most appropriate renewable resources in the region of interest to fully serve the electric distribution grid, referred to as the "mini-grid."

- Determine the most appropriate geographic and electric system boundaries of the electric distribution mini-grid.
- Assess the technical and market electricity potential of these identified resources within the specified markets of the mini-grid.
- Estimate the electric system public benefits of the full development of these renewable resources within the region of interest over the next 5 and 10 years. Identify candidate sites to participate RD&D pilot program activities.

The Chino Basin is an ideal location for undertaking this effort. It has one of the largest concentrations of dairy cows in the world, with over 300,000 cows located within a 50-square-mile area. It is also well suited for PIER research because IEUA, the local water basin entity responsible for treating wastewater, has led the region in its efforts to better manage the waste from the dairies and to explore alternatives to use it to produce energy. IEUA is a partner in the Commonwealth PIER Program.

1.3 Project 1.1 Deliverables

Project 1.1 includes the following report deliverables:

- 1.1.1 Review Previous Renewable Resource Assessments for California and Southern California and Define the Mini-Grid Study Area
- 1.1.2 Develop Animal Waste and Food Processor Database
- 1.1.3 Develop Landfill Database
- 1.1.4 Develop Sewage Treatment Plant Database
- 1.1.5 Photovoltaic Resource Assessment
- 1.1.6 Define the Mini-Grid Study Area
- 1.1.7 Assess the Biogas and PV Market Potential within the Mini-Grid
- 1.1.8 Develop Biogas and PV Resource Generation Profiles
- 1.1.9 Conduct Mini-Grid Power Flow Analysis
- 1.1.10 Prepare a Prioritized List of Pilot Projects for Biogas and PV Projects

This report is the deliverable for Task 1.1.10 as it relates to Nonresidential Building-Integrated Solar Photovoltaics, Landfills, Sewage Treatment Plants, and Animal and Food Processing Waste. As stated above, this report reflects the results of extensive discussions with IEUA, landfill owners and operators in the four county area surrounding the study area (San Bernardino, Riverside, Los Angeles, and Orange), and technology and equipment vendors.

1.4 Mini-Grid Analysis

As part of the Project 1.1, Planning and Analysis Project, Task 1.1.9b developed computer analysis models of the study area electrical transmission, substation and distribution system serving the area. This mini-grid system was analyzed to determine the effects of renewable resource development on the system. Areas analyzed included:

- Power flows
- Losses during peak and light load conditions
- Voltage control, regulation and var supply
- Transmission and distribution system and customer reliability
- Impacts of reverse power flow on distribution system equipment
- Potential voltage flicker problems

Based on the Inventory reports done as part of Project 1.1, renewable resource penetration rates were estimated for landfill gas to energy, animal waste to energy, enhanced anaerobic digestion and building integrated photovoltaic systems. Penetration of up to 51.4 MW was considered in the study. This is less than 10 percent of the peak mini-grid loads, which totaled more than 600 MW in 2007 and 2012.

At the penetration levels evaluated, less than 10 percent of the peak load, the analysis found that:

- The mini-grid loss reductions are relatively small
- There were no voltage reduction or power factor correction benefits or penalties identified
- There might be voltage regulation issues if sufficient renewable resource is placed at the end of a feeder (in this case, at IEUA Regional Plant 1 ((RP-1))
- Voltage flicker is not expected to be a problem
- If sufficient renewable resource is placed on a feeder, reverse power flows will occur, which can result in voltage regulation concerns and concerns about the proper functioning of protective devices. In the analysis, this occurred on feeder D6, which serves RP-1 and feeder F3 that serves the Milliken Landfill, which was used as a proxy location for the landfill bioreactor.
- There can be significant distribution system improvement deferrals as a result of reduced feeder loading
- Transmission and subtransmission deferrals and loss reductions are difficult to identify and quantify because they serve much broader areas

The analysis found that the location of renewable resource projects within the mini-grid will benefit the electric transmission and distribution system, with the benefits being more apparent at the distribution level.

No apparent constraints to the addition or location of renewable resources within the mini-grid were identified.

Because of this, the development of the prioritized site list placed a strong preference on projects located within the mini-grid.

1.5 Projects in the Commonwealth Program

The Commonwealth Energy Team proposed projects include:

- Project 2.1 Enhanced Landfill Gas Production Using A Bioreactor Project
- Project 2.2 Enhanced Energy Recovery Through Optimization Of Anaerobic Digestion And Micro-Turbines
- Project 3.1 Dairy Waste To Energy Project
- Project 3.2 Building Integrated PV Testing And Evaluation Project
- Project 3.3 Building Integrated PV On Public Facilities

The purpose of this report is to prioritize the sites for the landfill bioreactor, enhanced anaerobic digestion and micro-turbines, the dairy waste to energy, and the Building Integrated PV project.

1.6 Report Content and Organization

The Commonwealth team completed the Planning and Analysis portion of this effort by assembling a team of experts led by its biogas team lead, CH2M HILL and its Program Planning and Evaluation lead Itron. CH2M HILL's efforts and elements of this report were supported and supplied by NIRAS, a Danish firm with internationally recognized expertise in biogas projects using animal waste, and Tetra Tech Inc., a U.S. environmental consulting and engineering firm with technical expertise in manure inventory and management. The efforts in preparing this report were overseen by the Commonwealth PIER Program Manager, Itron. The results will be used to define testing done in subsequent stages of the overall CEC project.

Based on current experience, this report identifies proposed host sites for the testing of biogas production and utilization projects and methods to improve the economics of biogas production /utilization.

This report is organized as follows:

- **Section 1** introduces the Commonwealth Energy Renewables Mini-grid program, provides background information on the Chino Basin, and presents an overview of the Commonwealth PIER Program and the Planning and Analysis Project.
- **Section 2** summarizes the prioritization criteria used and the prioritized sites identified for further study.
- **Section 3** discusses the selection of sites for a landfill bioreactor(s).
- **Section 4** discusses the selection of sites for possible enhanced anaerobic digestion projects.

- **Section 5** describes the selection of dairy waste-to-energy sites and possible technologies that can be investigated.
- **Section 6** describes the selection of potential solar PV sites.

Under separate tasks, the Commonwealth Team is developing more definitive discussion of the technologies to be investigated. This work is under Project 2.1 for landfill bioreactors, Project 2.2 for enhanced anaerobic digestion at sewage treatment plants, Project 3.1 for dairy-waste to energy projects, and Project 3.2 for building integrated PV.

SECTION 2

Prioritization Approach

This section describes criteria used to prioritize sites. As discussed below, this process involved determining the sites' technical suitability and the evaluation of qualitative criteria that have a direct effect on the probable success of demonstration projects. Where appropriate and meaningful, quantitative criteria were used.

2.1 Site Selection

Prior reports inventorying the Chino Basin biogas resource have been prepared for four resource areas:

- Landfills suitable for bioreactor development
- Sewage treatment plants
- Dairy manure and food processors
- Building-integrated PV

Based on these inventories, the next step is to develop a prioritized list of leading sites for demonstration of biogas to energy projects; specifically a landfill bioreactor, enhanced anaerobic digestion and microturbines, and dairy waste to energy.

This report identifies leading sites for demonstration projects. The specific technologies will be reviewed and assessed in subsequent reports under:

- Project 2.1, Enhanced Landfill Gas Production Using a Bioreactor Project
- Project 2.2, Enhanced Energy Recovery Through Optimization of Anaerobic Digestion and Microturbines
- Project 3.1, Dairy Waste to Energy
- Project 3.2, Building Integrated PV Testing and Evaluation and
- Project 3.3, Implementation of BI-PV on Public Facilities

2.2 Prioritization Criteria

2.2.1 Prioritization Criteria List

This prioritized site selection is based on a number of criteria, including:

- Site technical suitability for demonstrating a technology
- Permitting capability and code compliance
- Statewide applicability
- Project champion/host
- Location relative to the mini-grid area

- Technological risk
- Lead-time
- PIER Project Budget
- Availability of matching funds
- Host/Developer economics and financing

2.2.2 Discussion of Criteria

Each of these is discussed briefly below.

Site Technical Suitability: The site must be suitable for the installation and operation of a demonstration project. This includes the presence of suitable feedstock, space, existing processes that support a particular technology to be demonstrated, utility interfaces, and other supporting infrastructure. If there is no space for the demonstration project, the site will necessarily have a low priority.

Permitting Capability and Code Compliance: At a given site there must be an expected ability to permit the demonstration project. This can include, but is not limited to, air emissions, land use, and ground water protection. If the demonstration project is at an existing facility with existing permit limits that allow the project to occur, that is a strong positive for the site.

Statewide Applicability: Can the demonstrated technology by applied statewide at similar facilities? If a technology is dependent on a unique set of circumstances at a particular site, it will have less statewide applicability than if it is a technology that can be applied at many installations. A good example is a technology that requires a certain scale size in order to be economic and that scale occurs rarely in the State.

Project Champion/Host: For the demonstration to be successful, the project host must be supportive and interested in demonstrating the technology. Without a project champion and host and the concurrent institutional support for the project, the chances of a successful demonstration over a number of years are low. If the project host is reluctant about the project, there will be little or no support for any project modifications needed to make the technology work. It can also lead to early abandonment of the project (technology) before a suitable demonstration can be accomplished.

Location Relative to the Mini-Grid: Is the site located within the mini-grid and is its location conducive to determining its benefit to an electrical system? The Chino Basin has a very large potential for renewable energy production from biogas. The mini-grid is a subset of the Chino Basin and may or may not encompass sites suitable for a particular technology. When a choice can be made, a project site within the mini-grid is preferable to one that is not. Also, larger more significant projects in terms of power generation are preferred over smaller projects.

Technological Risk: Some technologies are more fully developed than others, with several vendors offering products that take somewhat different approaches to the same technology. A good example is ultrasound equipment to accomplish cell hydrolysis at municipal wastewater treatment plants. There are other technologies that are relatively immature or that have not been developed for the particular application, that may require a significant resource commitment to implement, and for which there are a limited number of vendors offering the technology. A good example is manure gasification.

Lead-time: Depending on the scale of the project and the nature of the site, the lead-time for project construction/installation could be a couple of years. The preference is for sites that can accept the project with a minimum of permitting and lead-time.

PIER Project Budget: Demonstration projects that have high front-end capital costs and potentially high operating costs are less desirable than projects that have lower front end costs and operating costs. The demonstration of several lower cost technologies with statewide applicability is preferable to one large-scale project with less statewide applicability.

Availability of Matching Funds: To the extent there are matching funds available, either from other programs or the host, PIER funds can be leveraged to a greater extent. It was found that site owners supportive of biogas renewable energy projects have a greater ability to access matching funds.

Host/Developer Economics and Financing: Host support for a project is perhaps the single most important criterion. A supportive host will have a greater interest in contributing to the project financing and economics whether through matching funds or the labor and miscellaneous support needed for the project on a day-to-day basis. If technology vendors are willing to participate by providing equipment and testing at reduced costs, the PIER project budgets can accomplish more work.

Based on the above considerations, we have prioritized a list of potential sites for demonstration projects. The prioritization process is discussed more specifically for each of the three areas in the section discussing that particular area: landfill bioreactor, sewage treatment plants, and dairy manure and food processor waste to energy.

Table 2-1 summarizes the criteria found to be most relevant to the site selection process.

Table 2-1 Primary Site Selection Criteria

		Enhanced Energy Recovery Through Optimization of Anaerobic Digestion and Microturbines				Dairy Waste to Energy		
Criteria	**Landfill Bioreactor**	**Ultrasound**	**Thermal Hydrolysis**	**Biogas Treatment**	**Micro-turbines at Sewage Treatment Plants**	**Anaerobic Digestion**	**Gasification**	**Building Integrated PV**
Site Technical Suitability	X	X	X	X		X	X	X
Permitting Capability and Code Compliance	X							
Statewide Applicability							X	
Project Champion/Host	X	X	X	X	X	X		X
Location Relative to the Mini-Grid				X	X	X		X
Technological Risk							X	
Lead-Time							X	X
PIER Project Budget							X	X
Availability of Matching Funds							X	X
Host/Developer Economics and Financing							X	X

SECTION 3

Landfill Bioreactors

This section discusses the selection of sites for a landfill bioreactor(s).

3.1 Brief Technology Description

A landfill bioreactor is a landfill cell that includes provisions to (1) recirculate the liquids that permeate the land-filled material (known as "leachate"), and (2) add additional liquid. The recirculation and addition of liquids substantially accelerates the decomposition process of the waste material and the production of biogas, which can be used to produce renewable energy. The landfill bioreactor concept, its current state of development, and its applicability to the PIER Program are described further in the October 2002 document titled *Inventory Report for Potential Bioreactor Landfills*, submitted by CH2M HILL as part of the PIER Program.

Development of a landfill bioreactor is a key element of the Commonwealth Energy program.

Before a landfill cell can used as a bioreactor, it must be lined for containment in accordance with current U.S. Environmental Protection Agency (EPA) and applicable state requirements.

Current landfill regulations allow the recirculation of leachate if the lining system meets the composite liner requirements of the regulations. The regulations prohibit the addition of free liquids into a landfill, unless a waiver is granted by an authorized state agency. The use of bioreactors has not been approved in California as an acceptable waste management practice. However, a pilot bioreactor project at the Yolo County Landfill has been approved by the California State agencies subject to certain conditions; operation of this bioreactor has not resulted in any problems. Presumable, a California Energy Commission-sponsored bioreactor project could obtain a similar approval.

3.2 Site Selection

The four-county area (San Bernardino, Riverside, Orange, and Los Angeles) immediately around the study area was inventoried for landfills that might be suitable host for a bioreactor. The results of this effort were reported in our *Inventory Report for Potential Landfill Bioreactors*. Seventy-one landfills were identified in the four-county area. Only existing permitted solid waste landfill sites were considered as potential sites because of the great uncertainties involved in siting and permitting new landfills.

These 71 landfills were screened using the following criteria:

- The landfills have current waste disposal facility permits.

- The landfills receive at least 10tons per day of MSW or other biodegradable materials (that is, construction and demolition waste landfills and landfills that receive largely inert materials were not considered).
- The landfills have at least 2 years of additional permitted capacity remaining, which will allow conversion to a bioreactor during the active life of the landfill.

This process reduced the number of candidate landfills to 33. Additional data was then gathered on these landfills and attempts made to contact the owners regarding their willingness and ability to consider converting the landfill into a bioreactor. This step reduced the list of potential landfill sites further to 16.

This list was then evaluated based on the following considerations:

- All or most database parameters indicated favorable conditions for bioreactor development—none was questionable
- Large potential power production
- Proximity to the study area
- Owner's expressed willingness to consider modifying the site operation to a bioreactor

Neither of the two permitted landfill sites within the mini-grid area were deemed to meet the selection criteria because one of the sites (Milliken) is no longer permitted to accept waste and the other (Colton) is expected to close about 2006.

Four landfills were chosen as best candidates for a bioreactor project. All four lie outside the mini-grid, but within the immediate surrounding four counties. Figure 3-1 is a map showing the four landfill locations relative to the mini-grid Southern California Edison substations.

[For purposes of the mini-grid electric system analysis, the actual electrical generation parameters for the selected site was modeled as though the bioreactor is located at the Milliken landfill site within the mini-grid area.]

The four sites chosen as most promising are described in Section 3.3.

The bioreactor concept is potentially replicable at many existing or new landfill sites around the state that meet the qualification criteria. Landfill bioreactors are scalable to any site size and have the additional positive effect of improving the economics of landfill gas generation by accelerating landfill gas production. Project implementation at any of the sites identified in Section 3.3 will demonstrate a concept which, if applied at the 16 highest-potential sites identified in the four-county area around the mini-grid, could provide 265 megawatts (MW) of new distributed generation from a renewable source.

3.3 Issues Common to All Sites

The following issues are common to all potential bioreactor project sites:

- Permitting Capability
- Environmental Impacts
- Lead Time

- Minimum/Optimal Size Range
- Facility Interface Requirements
- Interest/Matching Funds

Figure 3-1 (11x17)/1

Figure 3-1 (11x17)/2

3.3.1 Permitting Capability

Because of the addition of free liquids to the landfill, permitting a bioreactor project requires the regulatory agencies to specifically approve the bioreactor development at a given site. To obtain this approval the landfill must have a permit. For operating landfills, their permit requires implementation of a lining system designed to capture water that seeps through the landfill ("leachate") and manage this leachate so that groundwater is protected. Because a landfill bioreactor involves adding additional liquid to the landfill, special approval must be obtained to permit the bioreactor process. EPA has introduced but not finalized regulatory changes to allow for site-specific waivers for research projects and the State of California has made provisions and given specific approval at a demonstration site. This process is described further in the *Inventory Report for Potential Bioreactor Landfills*.

The four sites selected and described in Section 3.4 all have existing permitted operations and good potential for obtaining the permit amendments and other approvals needed to permit a landfill bioreactor at the site.

Unless otherwise noted in the following discussion, the permitting issues are the same for the four sites.

3.3.2 Environmental Impacts

Environmental impacts from landfill bioreactors are summarized as follows:

- Landfill bioreactors have the positive effect of offsetting greenhouse gas (GHG) production by generating power from waste biogas that might otherwise be generated from combustion of fossil fuels.
- The accelerated decay of waste matter compacts its volume and has the effect of increasing available space in the landfill.
- The bioreactor process introduces additional liquid into the landfill, resulting in additional leachate that must be managed.
- An air permit would be needed for the combustion engine or turbine that converts the biogas produced into electricity. The alternative is to flare the biogas, which would also require an air permit.)
- The landfill decomposition process may provide a means to treat contaminated groundwater that can be added to accelerate the decomposition process, depending on the nature of the contamination.

3.3.3 Lead Time

Lead times for installed landfill bioreactors vary, depending on size of the cell and other site-specific factors. The process includes permitting (typically a 1-year minimum), installing equipment, and ramping up gas and power production (1 to 2 years depending on whether the project starts at a point where gas is already being produced or must wait for gas production to start). The total timeline might be 2 to 3 years for a typical project.

3.3.4 Minimum/Optimal Size Range

The minimum size of a cell is about 2 acres. This translates very roughly into approximately 50 cubic feet per minute (cfm) of gas or 100 kilowatts (kW) of power, dependent on site-specific factors. Each landfill bioreactor would be sized specifically to the site.

3.3.5 Facility Interface Requirements

A water supply, potentially millions of gallons per year, may be needed.

An electric system interconnection is needed for the power project, to transmit the power to where it will be used. Bioreactor power generation capability tends to be greater than for many biogas projects, with the expectation that the generation will need to utilize the local and possibly regional grids; the power is not consumed onsite.

Also, the lining and leachate systems mentioned above are needed.

3.3.6 Interest/Matching Funds

Funding of the bioreactor development is a potential issue. Based on conversations with potential site hosts, it is likely that host owners will require external funding to develop a bioreactor. Because of the long permitting, installation, and ramp-up periods described above, benefits to the owners from a project are delayed and long-term, while up-front investment costs are immediate. For projects to be economically viable, funding and financing assistance is most likely necessary.

As a result, site hosts that are willing to "champion" the bioreactor development is a significant consideration it site selection.

3.4 Four Sites Selected for Further Consideration

The four sites selected for further consideration as landfill bioreactor sites were:

- Mid-Valley in San Bernardino County
- San Timoteo Landfill in San Bernardino County
- Badlands Landfill in Riverside County
- El Sobrante Landfill in Riverside County

Additional detail on the landfills is included in Table 3-1.

3.4.1 Mid-Valley Landfill Site (San Bernardino County)

Of the four sites, the Mid-Valley landfill is closest to the mini-grid area, lying 5 miles to the northeast of the study area on a 498-acre site. The site is owned by San Bernardino County, and operated under contract by Burrtec Waste Industries Inc. It is expected to continue in active operation until at least the year 2033. Most of the operational area is unlined. However, one newer section is lined and has an unfilled area, making that area potentially suitable for a bioreactor. Future filling areas are to be lined as well. The operating lined area has leachate and biogas collection systems installed and operating. Potential biogas power from the site is estimated at 8 MW.

TABLE 3-1
Information on Four Finalist Sites for Landfill Bioreactor

Landfill Name	Unit	Mid-Valley Refuse Disposal Site	San Timoteo Solid Waste Disposal Site	Badlands Disposal Site	El Sobrante Landfill
SWIS No.		36-AA-0055	36-AA-0087	33-AA-0006	33-AA-0217
California Landfill Class		III	III	III	III
Waste Shed		County/Metro. Exclusive	County/Metro. Exclusive	Regional Waste District	Regional Waste District
Ownership		Public	Public	Public	Public
Owner Entity		San Bernardino County	San Bernardino County	Riverside County	Western Waste Industries
Operation		Private	Private	Public	Private
Operator Entity		Burrtec Waste Industries	Burrtec Waste Industries	Riverside County	Western Waste Industries
Location					
Landfill Address		1/2 Mi N Highland Ave; 1/4 Mi E of Sierra, CA 92377	San Timoteo Canyon Road, CA 92373	31125 Ironwood Avenue, CA 92373	10910 Dawson Canyon Rd, CA 91719
City		Rialto	Redlands	Moreno Valley	Corona
County		San Bernardino	San Bernardino	Riverside	Riverside
Zip		92376	92373	92388	91718
Capacity					
Total permitted capacity	Cubic Yards	62,000,000	14,800,000	27,959,140	184,930,000
Total capacity remaining	Cubic Yards	694,058		15,036,809	3,674,267
Acreage					
Total site area	acres	498	366	1093	1322
Area permitted for disposal	acres		114	150	495
Used Acres	acres	142	114	67	90
Opened / Projected Close					
Year started operations		October 6, 1978	November 21, 1980	May 26, 1966	May 28, 1986
Year final closure (actual or expected)		January 1, 2040	December 31, 2030	January 1, 2018	January 1, 2030
Volumes & Types of Waste Collected					
Waste Types Accepted		C&D, MSW, Other Special/Designated Waste, Tires (Auto), Tires (Tractor), Yard Waste	C&D, MSW, Other Special/Designated Waste, Tires (Auto), Yard Waste	C&D, Dry Industrial, MSW, Tires (Auto), Yard Waste	C&D, Dry Industrial, MSW, Sludge, Tires (Auto), Yard Waste
Household	tons/year	299,421	102,375	454,987	1,446,814
Construction/Demolition	tons/year	99,807	34,125	1,096	33,629
Organic or Yard Wastes	tons/year	57,033	19,500	3,951	11,509
Industrial Wastes	tons/year	0	0	671	706
Special Wastes	tons/year	0	0	0	0
Tires	tons/year	0	0	0	0
Total		**456,261**	**156,000**	**460,705**	**1,492,658**
CIWMB Reported Tons: 2001		307,517	139,370	500,482	1,120,378
Has year-by-year tonnage history?	Yes/no	Yes	Yes	Yes	Yes
Has year-by-year waste projections?	Yes/no	No	No	No	Yes
Lining System?	Yes/no	Yes	Yes	Yes	Yes
Type of lining system		Composite	Composite	Composite Liner	SubTitle D +
Area with liner in place	acres	12	12	55	55
Area of liner covered with refuse	acres	135	114	86	78.5
Area of unfilled liner	acres	2	0	6	0
Lining System Comments					
LFG characteristics					
Has LFG collection system?	Yes/No	Yes	Yes	Yes	Yes
Area covered by LFG collection syster	acres	135	114	86	78.5
Total current LFG collected	Cu Ft / Min	3000	200	300	1510 ACFM
Estimated peak LFG collection rate	Cu Ft / Min			1900	2110 ACFM
Year of peak LFG collection	Year			2022	2002
Potential current power output	kW or other			1000 kW	
Potential peak power output	KW or other			4000 KW	
Has LFG utilization system?	Yes/No	No		Yes	No
Output of LFG utilization system	KW or other	--		1100 KW	--
Has LFG analytical data?	Yes/No	No		Yes	Yes
Time period covered by LFG data		--		2001	12-1993 - Present
Frequency of LFG data		--		Monthly	Weekly
Has LFG projection curve?	Yes/No	--		Yes	Yes
LFG Comments		Gas collected and combusted using an enclosed flare. System installed in 1994			
Leachate characteristics					
Has leachate collection system?	Yes/No	Yes	Yes	Yes	Yes
Annual leachate collected	Gal / Year	No	Yes	59,100 gal/year	120,000
Peak leachate collected	Gal / Day	0	0	59,100 gal/year	120,000 Gal/Year
Do you make projections?	Yes/No	No	No	No	No
Year of peak leachate projection?	Year	--	--	--	
Projection peak leachate production	Gal / Day	--	--	--	
Has leachate analyses?	Yes/No	No	No	Yes	Yes
Leachate analytical parameters avail	Yes/No	--	--	Yes	Yes
Time period covered by leachate data		--	--	1994-Present	1992 - Present
Recirculates Leachate?	Yes/No	Yes	Yes	No	No

Table 3-1 insert page

Burrtec reports the site's gas rights are split between the older, unlined areas and the newer lined area. In the lined area, San Bernardino County has reportedly retained the rights to harvest the gas, so that an agreement with the County for using gas harvested from a bioreactor in the lined area for power generation could be possible.

The County and the landfill operator have expressed willingness to host a bioreactor project at this landfill. In a recent meeting in San Bernardino involving County staff, representatives of the Energy Commission and the Commonwealth Team, Water Quality Control Board the relative merits of this site and the San Timoteo sites were discussed. Based on this discussion, the County determined that the San Timoteo site was their preferred location for the bioreactor project. San Timoteo Landfill (San Bernardino County)

The San Timoteo landfill is second farthest from the mini-grid, lying 15 1/2 miles to the east of the study area on a 366-acre site. San Bernardino County also owns this site, which is also operated by Burrtec. The site is expected to continue in active operation until 2030. The current operational fill area is 114 acres, most of which is unlined. However, a 12-acre-lined section is currently being filled, making that area potentially suitable for a landfill bioreactor.

A biogas collection system covers the entire 114-acre fill area, and produces about 200 cubic feet per minute (cfm) of biogas. This gas is currently flared.

The lined fill area has a leachate collection system. However, no leachate production has yet been recorded. Potential biogas power from the site is estimated at 2 MW.

Both the County and Burrtec have expressed willingness to host a bioreactor project at this site. As noted above, San Bernardino county has expressed the preference to have the bioreactor site developed at the San Timoteo landfill.

3.4.2 Badlands Landfill (Riverside County)

The Badlands landfill is farthest from the mini-grid, lying outside the grid approximately 22 1/2 miles to the east in Moreno Valley, on a 1,093-acre site. The site is owned and operated by Riverside County Waste Management Department, a public agency. It is expected to continue in active operation until 2018. The current fill area is 86 acres, most of which is lined (suitable for a landfill bioreactor), including a 6-acre lined section that is not yet filled.

A biogas collection system covers the entire 86 acre fill area, and currently produces about 300 cfm of biogas. A gas generation system is currently operational, producing about 1 MW of electricity. This site has biogas generation potential of 15 MW, and gas production is projected out to a peak of 1,900 cfm in 2022. The lined fill area has a leachate collection system that has been in place since 1994, and reported collecting 59,000 gallons in 2001.

The owner/operator has expressed willingness to host a landfill bioreactor project at this site.

3.4.3 El Sobrante Landfill (Riverside County)

The El Sobrante landfill is the second closest to the mini-grid, lying 14 miles to the south-southeast, on a 1,322-acre site. The site is owned and operated by Western Waste Industries, a private company. It is expected to continue in active operation until 2030. The current fill area is 78 acres, most of which (55 acres) is lined, and suitable for a landfill bioreactor.

A biogas collection system covers the entire 78-acre fill area and currently collects about 1,500 cfm of biogas, which is flared. This site has the highest biogas generation potential of the four chosen—a total of 22 MW.

A leachate collection system has been in place since 1992, and collects about 120,000 gallons per year.

The owner/operator has expressed willingness to host a landfill bioreactor project at this site.

3.5 Landfill Bioreactor Site Selection

San Bernardino County owns two of the sites, San Timoteo and Mid-Valley. Of the four sites examined in detail, Mid-Valley is closest to the study area. The County has indicated interest in locating a landfill bioreactor at either site.

The ability to permit a bioreactor is essentially the same at the four sites.

San Timoteo is the preferred site due to San Bernardino County's preference to host a new landfill bioreactor there, based upon its review of relative merits and risks of both the San Timoteo and Mid-Valley sites. San Timoteo has a 2 MW estimated potential.

Mid-Valley has a longer expected life, and has a new cell that is attractive because it is already double-lined, has relatively little material in place and can be easily adapted for use as a bioreactor. It is also closest to the mini-grid study area. It has an 8 MW electric power potential. It would fall second in priority to the San Timoteo site.

SECTION 4

Enhanced Biogas-to-Energy Conversion at Wastewater Treatment Plants

Figure 4-1 is a map showing the location of the area sewage treatment plants in or near the mini-grid that may offer demonstration project sites. Facility information is provided in Table 4-1. It can be seen that IEUA is the only entity owning/operating wastewater treatment plants within the mini-grid. The City of Corona and the Riverside Regional Water Quality Control Board also operate wastewater near the mini-grid.

This suggests that the IEUA plants are a logical host sites for demonstration projects.

The Commonwealth Energy Team is investigating several strategies for improving biogas to energy conversion at wastewater treatment plants as part of Projects 2.1 and 2.2. These strategies include:

- Enhanced Anaerobic Digestion at Sewage Treatment Plants
- Biogas Treatment for Energy Conversion Systems
- Testing Microturbines at Sewage Treatment Plants
- Advanced Efficiency Technologies (Heat Recovery)
- Advanced Efficiency Technologies (Improved Performance)

4.1 Enhanced Anaerobic Digestion at Sewage Treatment Plants

A brief discussion of the technologies being studied and why a given technology might be more appropriately demonstrated at a particular site follows.

4.1.1 Ultrasound

Technology

Ultrasound is sound energy at frequencies above 20 kHz, above the audible range for humans. When introduced into a liquid, high-power ultrasound can produce a phenomenon known as “cavitation.” Cavitation is the formation, growth, and rapid collapse through implosion of micro-bubbles in a liquid. Research has shown that the greatest benefits occur when secondary sludges are sonicated. The increase in gas production is much lower when primary sludge is sonicated, as these solids are readily putrescible and less limited by hydrolysis. Sonication can have the following beneficial effects:

- Increased solids destruction
- Increased biogas production
- Improved downstream de-watering of the sludge
- Increased digester capacity
- Reduced biosolids treatment needs

TABLE 4-1
Wastewater Treatment Plant Facility Information

FACILITY						
Name of Facility		Regional Plant No. 1	Regional Plant No. 2	Regional Plant No. 4	Regional Plant No. 5	Riverside Regional Water Quality Control Plant
OWNERSHIP						
Owner ID No.		IEUA	IEUA	IEUA	IEUA	Riverside
Tax-Exempt		Yes	Yes	Yes	Yes	Yes
Project Development/Ownership/Operation		Yes	Yes	Yes	Yes	Yes
Interest in Providing Matching Funds Toward Project Development		Yes	Yes	Yes	Yes	Yes
ELECTRIC UTILITY INFORMATION						
Electric Utility		SCE	SCE	SCE	SCE	City of Riverside
SCE Substation Serving Load		D	U	I	U	Outside of Mini-grid
SCE Feeder Serving Load		D6	U7	I9	U2	
Parameter	**Unit**					
Current flow annual average	mgd	39.8	Solids 15 mgd; Liq 4.5	3.5	0	33.58
Future flow average	mgd	Solids - 60 mgd/Liq 44 mgd	12 mgd + 10 mgd CCWRF	14	Solids -55 mgd/ Liq 30 mgd	47.58
Primary sedimentation	Yes/No	clarifiers + gravity thickener	clarifiers + gravity thickener	N		yes
Secondary treatment	Type	ASP, BNR	ASP, BNR	Anoxic basin + Oxid ditch		aeration basins with anoxic zone
Thickeners for Waste Activated Sludge	Yes/No	DAFT	DAFT	sludge age controller		yes - DAFT
Anaerobic digestion	Yes/No	3-phase	conventional	RP-1 or aerobic digestion		Yes
Dewatering	Type	belt press	belt press + centrifuge	centrifuges		Belt Presses
Biosolids disposal & reuse	route	co-composting	co-composting	RP-1 or co-composting		Land application/composting
Energy recovery (biogas reuse)	Type	co-generation	co-generation	N		Cogeneration
Influent Characteristics - annual average						
Total Suspended Solids	lb/d	89,308	9,027	8,017		60,492
Biological Oxygen Demand	lb/d	80,717	7,444	7,450		58,812
Primary Sludge - annual average						
Primary Sludge flow	mgd	0.18	0.05	Solids go to RP-1		0.1043
Primary Sludge Volume	lb/d	74,328	20,116			36,534
Primary Sludge Total Solids Percentag	%	5.00	4.89			4.2
Primary Sludge Volatile Solids Percent	% of TS	79.3	82.0			81.5
Waste Activated Sludge - annual average						
Thickened Waste Activated Sludge (TV	mgd	0.08	0.04	Solids go to RP-1		0.6
TWAS Volume	lb/d	32,285	11,626			175140
TWAS TS%	%	4.70	3.59			3.5
TWAS VS%	% of TS	77.6	73.9			79.5
Anaerobic Digestion - annual average						
Digester Number of Units	no.	6	2	0	0	2
Operating Volume per digester	mg	2@0.92, 2@0.85, 1@1.25, 2@1.68	1.30	NA	NA	1.64
Total digester volume	mg	7.3	2.60	NA	NA	3.28
Total flow to digesters	mgd	0.26	0.09	NA	NA	0.7043
Digester Hydraullic Residence Time	days	28.0	29.3	NA	NA	18
Total solids to digester	lb/d	103,279	31,005	NA	NA	211674
Digester feed TS%	%	4.7	4.2	NA	NA	3.6
Digester feed VS%	%	77.9	79.4	NA	NA	80
Digested sludge TS%	%	2.4	2.3	NA	NA	2
Digested sludge VS%	%	57.8	64.0	NA	NA	65
Digester Volatile Solids Reduction	%	61.1	53.9	NA	NA	54
Digester temperature	F	98-125	119-125	NA	NA	100
Dewatering - annual average						
Cake dryness	%	19.7	19.0	NA	NA	12
	wtpy	65,500	17,720			39,000
Biosolids Disposal/Reuse						
Biosolids haulage costs	$/wet ton	21	22	NA	NA	30
Biogas System - annual average						
Gas production	cf/d	769,453	308,778	NA	NA	408,358
Gas Production per pound of VS	scf/lb	9.563	12.548	-	-	2.418
Gas Producton per pound of VS destro	scf/lb	15.643	23.291	-	-	4.477
Gas storage	gallons	35,000	30,000	NA	NA	blended: 26,000 gallons
Gas cleaning system	type	iron sponge, water separator dessicant dryer, siloxane filter	particulate filter, dessicant dryer, siloxane filter	NA	NA	FeCl3 and condensate traps
Biogas quantity used	cf/d	748,253	308,778	NA	NA	408,358
	k therms	1325	580	NA	NA	0
Biogas quantity flared	cf/d	21,200	0	NA	NA	0
Flaring emissions	ppm	-	270	NA	NA	0
On-site Energy Generation & Recovery						
On-site power generation capacity	kW	#REF!	#REF!	#REF!	#REF!	3300
Boiler Capacity	MBTU	-	-	-	-	8.36
Natural gas consumption annual av.	k therms	1820	247	880	2,701	-
Excess capacity over exstg biogas pro	%	58%	30%	100%	100%	60%
Energy Utilization						
Total plant electricity consumption (1 y	kW	26,209,920	6,894,120	7,332,120	22,504,440	3163
	kWh av	2992*	787*	837*	2569*	65,047
	kWh peak	3590*	945*	1004*	3083*	67,288
Facility Electrical System						
Peak Demand	kW	3127	1725	862	-	3163
Annual kWh Purchased		9,149,742	3,057,633	4,763,463	-	23,738,640
Power cost (per purchased kWh)		$0.10	$0.13	$0.09	$0.12	$0.09
Facility Summary:						
Enhanced Digestion Technologies		IEUA RP-1	IEUA RP-2	IEUA RP-4	IEUA RP-5	Riverside
Thermal hydrolysis		Y	Y	in future	in future	Y
Ultrasound		Y	Y	in future	in future	Y
Digester gas cleaning		Y	Y	in future	in future	N
Co-generation		Y	Y	in future	in future	N
Potential Demonstration Projects		Y	Y	N	N	Y
Comments	* taken from IEUA Energy Master Plan					

Figure 4-1 (11x17)/1

Figure 4-1 (11x17)/2

The capital cost to implement is low and it is easy to add to an existing facility. Immediate positive impact to digester gas production is possible, depending on historical digester performance. The additional biogas produced can be utilized at the treatment plant to offset electrical demand.

Site Selection

Potential sites for applying this technology exist within and outside the mini-grid. This potential is further detailed in the Inventory Report for Sewage Treatment Plants (CH2M HILL, October 2002).

The IEUA plant RP1 uses a three-phase acid digestion process, the performance of which is usually higher than with conventional mesophilic digestion, suggesting that the benefits of sonication will be less at plants using the phased acid digestion process. Plants using a conventional mesophilic digestion process may see a greater improvement in biosolids destruction and gas production. RP-2 uses a phased thermophilic/mesophilic digestion process, which would see less benefit from sonication of a mesophilic-only process. Biosolids from RP-4 are sent to RP-1 for treatment and as a result, there is no opportunity for enhanced digestion at RP-4. Biosolids from the Carbon Canyon Wastewater Reclamation Facility are sent to RP-2 for treatment. RP-5 is a new plant and solids treatment will be done at RP-2 until about 2020. As a result, the IEUA plants do not provide good host sites for ultrasound demonstration projects.

The Riverside Regional Water Quality Control Plant, located outside the mini-grid to the east, uses a mesophilic digestion process and has expressed a strong desire to host an ultrasound demonstration project. Siting a demonstration project at Riverside will also involve another major entity involved in wastewater treatment in the mini-grid area.

Ultrasound technology is typically retrofitted into existing facilities, but it can also be a designed-in component of new anaerobic digestion facilities. The Riverside Water Quality Control Plant could benefit from additional gas production. Riverside has been investigating different technologies to optimize its digestion and cogeneration facilities and is very interested in pursuing the ultrasound equipment.

It can be seen that the site selection process consisted primarily of Site Technical Suitability and Project Champion/Host.

4.1.2 Thermal Hydrolysis

Technology

Thermal hydrolysis uses temperature and pressure to break open cell structure in predigested sludge, making it more available to be broken down into biogas. A thermal hydrolysis process has been identified that enhances digestion and dewaterability of biosolids, and can operate at biosolids concentrations exceeding 10 percent in the digester. Benefits to the digestion process include:

- Increased biosolids destruction
- Increased biogas production
- Significant improvement in biosolids dewaterability
- Increased digester capacity

- Can be designed to produce Class A biosolids, if desired

Figure 4-2 is a thermal hydrolysis schematic.

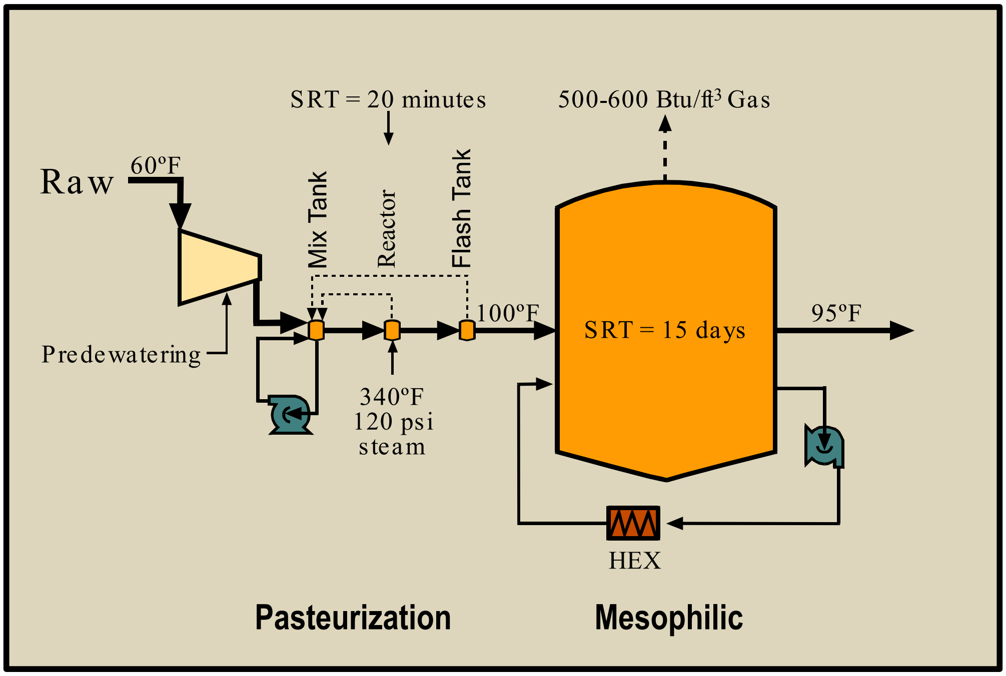

FIGURE 4-2
Thermal Hydrolysis Process Schematic

Site Selection

A discussed under Ultrasound, the benefits of Thermal Hydrolysis are greater for conventional mesophilic digestion processes than for phased acid digestion processes as used by IEUA at RP-1 and the phased thermophilic/mesophilic digestion at RP-2. As a result, the IEUA plants do not provide good host sites for thermal hydrolysis demonstration projects.

The Riverside Regional Water Quality Control Plant, located outside the mini-grid to the east, uses a mesophilic digestion process and has expressed a strong desire to host a thermal hydrolysis demonstration project. Siting a demonstration project at Riverside will also involve another major entity involved in wastewater treatment in the mini-grid area.

It can be seen that the site selection process consisted primarily of Site Technical Suitability and Project Champion/Host.

4.2 Biogas Treatment for Energy Conversion Systems

To run successfully in engines or turbines, biogas requires treatment remove moisture and certain contaminants and in some cases for consistency of heating value. The following are measures for biogas treatment considered in Project 2.2:

- Drying (Moisture Removal)
- Hydrogen Sulfide Removal

- Siloxane Removal
- Measure to Achieve Consistent Heating Value

These technologies can be demonstrated anywhere in the mini-grid area where biogas is being used to generate power.

4.2.1 Biogas Drying

Anaerobic digestion biogas naturally has high moisture content. This has a significant effect on the performance of engines and turbines. Drying of the gas is a basic requirement for using biogas. An excellent location to demonstrate equipment is IEUA’s RP-1 or RP-5 facilities.

4.2.2 Improved Hydrogen Sulfide (H_2S) Removal Technology

Hydrogen sulfide (H_2S) is a naturally occurring constituent of sewage treatment biogas. When biogas is used in an engine or turbine, H_2S is released in the exhaust gases. H_2S does not necessarily damage engines or turbines, but it does cause air pollution when released to atmosphere, and it affects the construction materials for heat recovery equipment. Also, H_2S can combine with residual moisture in the gas stream to form sulfuric acid, which will damage downstream equipment. An excellent location to demonstrate equipment is IEUA’s RP-1 or RP-5 facilities.

4.2.3 Siloxane Removal Technology

Dimthyl-Tetracyclo-Siloxane, commonly called siloxane in the context of biogas treatment, is a constituent of biogas produced from sewage treatment. Combustion of this siloxane containing biogas tends to leave a glass-like film of silica residuals on internal engine parts, impairing engine performance and significantly increasing system maintenance. Some existing biogas generation sites that lacked siloxane removal provisions experienced severe system degradation and the equipment was shut down and abandoned prematurely.

The new technologies recommended for further study and pilot are regenerable carbon and resin beds. It should be noted that the complexities of regeneration make these technologies practical only in larger applications. On very small applications, it is probably better to simply dispose of the carbon as is currently done.

An excellent location to demonstrate equipment is IEUA’s RP-1 facility.

4.2.4 Gas Mixing to Achieve Consistent Heating Value

These measures include removing carbon dioxide (CO_2) from the gas stream, blending biogas with natural gas, or blending biogas from several different sources.

Gas blending systems are custom-designed systems assembled from well-known components, such as blending valves. A mature technology for CO_2 removal is used in gas fields, but it has a negative effect (20 percent reduction) on heating value of the gas. New CO_2 removal technologies exist in prototype stage.

These measures are applicable at both new and existing biogas generation facilities. RP-1 has experienced biogas heat value consistency problems. Mixing biogas with natural gas at RP-1 would address this issue.

4.2.5 Site Selection

At IEUA RP-1, there are existing Waukesha engines, and existing Capstone microturbines to utilize the municipal waste digester biogas. The engines do not run because of emissions constraints. The Capstone turbines have experienced operating problems because of the presence of siloxanes in the biogas and are not currently operating. As a result, the biogas is being flared. Improved gas cleaning, particularly for siloxanes, would allow microturbines to be used. It is not clear if the existing microturbines have incurred damage from siloxane contamination and deposits.

At RP-5, the biogas from an existing manure digester is either sent to IEUA's desalting facility, about a mile away, where it is used to fuel engines or compressed using Copeland compressors to supply the gas to four Capstone microturbines (there is a compressor for each microturbine). The Copeland compressors have experienced problems because of the hydrogen sulfide and the moisture in the gas combine to create sulfuric acid, which has damaged the compressors. The Capstone microturbines at RP-5 are currently not operating.

IEUA is considering consolidating its existing microturbines and providing a comprehensive gas treatment for them at the RP-1 facility. Therefore, RP-1 is the preferred site for further PIER activity to develop gas treatment systems for microturbines, as described in Project 2.2 PIER activity can be conducted there most efficiently and projects developed there fit into the long range plans of IEUA. Development at RP-1 of gas treatment systems will also provide information that can be applied to biogas applications at many other waste treatment sites in California.

It can be seen from the above that the site selection criteria of most importance are location relative to the mini-grid, site technical suitability, and project champion/host.

4.3 Testing Microturbines at Sewage Treatment Plants

Microturbine generation technology is well known and used at sites in and around the mini-grid. Microturbines are seen as a possible alternative to reciprocating engines for biogas power generation, and may have some scalability advantage in certain size ranges that are smaller than the low end of the practical size range for reciprocating engines.

At RP-1, there is an existing 600-kW biogas fueled engine-generator that does not run because of emissions restrictions. Installing a smaller microturbine would allow the available biogas to be utilized and, because of the turbine's lower emissions, would meet the permit requirements of the site.

Several options are available for evaluating gas cleaning for microturbines at this site. The first involves using the existing Capstone microturbines. Under this scenario either:

- Low BTU gas generated and flared on site could be cleaned and blended with other biogas, and natural gas, as needed and then used in a microturbine, or
- Other biogas gas produced on site could be diverted to a gas cleaning system that could then be used on this project. This gas could then be treated with packaged or customized systems and tested in microturbines. Various treatment technologies can be tested under this approach.

Another option would be to install a new turbine(s), whether Capstone or Ingersoll Rand, because the existing turbines have experienced damage or to specifically demonstrate the Ingersoll Rand equipment, a 250 kW microturbine.

The relative merit of these options will be considered in the process selection report under Project 2.2. The discussion in Section 4.2.5 of this report is applicable to this selection evaluation.

The IEUA plants are the only wastewater treatment plants in the mini-grid area and therefore are the logical sites. IEUA is interested in demonstrating this technology further.

It can been seen from the above that the site selection criteria of most importance are location relative to the mini-grid, site technical suitability, and project champion/host.

4.4 Advanced Efficiency Technologies (Heat Recovery)

Any power generation using combustion engines (including biogas generation) generates waste heat. To the extent that this heat can be recovered and used, either to make more power or for other beneficial purposes, overall system efficiency is increased, and more power is generated from the same amount of resources. The applicable technologies investigated here include additional engines that can utilize the waste heat ("bottoming cycles") and absorption chillers, which utilize the waste heat to generate cooling for air-conditioning purposes.

RP-5 can provide opportunities to demonstrate bottoming cycle applications to improve the energy recovery efficiency of biogas utilization. These could include:

- Pentane Turbine (Organic Rankine Cycle)
- Steam Turbines for Biogas Generation Heat Recovery
- Stirling Engine
- Absorption Chillers at IEUA Headquarters
- Ceramic Coatings for internal combustion engines for improved performance
- Supplemental duct firing for bottoming cycle
- Coates engine

These technologies are examined in detail in Project 2.2, Enhanced Energy Recovery Through Optimization of Anaerobic Digestion and Microturbines.

IEUA has expressed interest in investigating and potentially hosting demonstration projects for these technologies at their RP-5 facility.

SECTION 5

Dairy Waste to Energy

As discussed in the *Inventory Report for Agricultural and Food Processing Facilities*, the most appropriate approach to conversion of dairy waste to energy in the Chino Basin is through centralized anaerobic digestion. Onsite digestion at individual dairies will often result in a level of biogas production that is too small to support the available engine-generators or micro-turbines and often diverts the dairy operators focus away from milk production. Also, the number of dairies in the Chino Basin is expected to decrease by 50 percent over the next 10 to 20 years and individual dairies may be reluctant to make the commitment to onsite digestion.

The best locations for demonstration projects are at IEUA's RP-1 and RP-5, located within the mini-grid, where there is existing manure digestion infrastructure and strong host interest in improving dairy waste to energy technology and practices. Figure 5-1 provides a map showing the location of the Chino Basin dairies, RP-1, and RP-5 relative to the mini-grid area and the Edison substation service areas.

As discussed below, there are a number of opportunities to enhance dairy waste and food waste conversion to energy at RP-1 and RP-5. The biogas production can be used to displace electricity purchases.

In the report for Project 3.1, there will be a detailed examination of the manure digestion facilities at the two plants, the operating experience with manure, and a discussion of possible projects and technologies that can be demonstrated.

There is also the possibility of a demonstration project for co-digestion of dairy waste and green waste at the West Valley Municipal Reclamation Facility.

5.1 RP-1 Manure Digester

At its RP-1 plant, IEUA converted the existing sludge blending tank and one of the existing digesters to a pilot test facility to investigate dairy cattle manure digestion and the recovery of digester gas for cogeneration. The manure digester was put in service in 2002.

Generally the manure is from dairy feed lanes. It is manually bar-screened to remove rocks. Water is added to adjust the slurry concentration. The slurry is then shredded and pumped to the two blending tanks. Steam injection is provided to allow heating the tanks' contents for thermophilic acid phase digestion.

The content of the blending tanks, also referred to as the acid phase digesters, is pumped to Digester No. 4, which can operate in either thermophilic or mesophilic mode. The content of Digester No. 4 can be pumped to belt presses or a centrifuge for dewatering. The dewatered sludge cake from the centrifuge or belt press is conveyed to hauling trucks.

Difficulties with centrifuge plugging have made the belt press the preferred dewatering method. The centrate is returned to the filtrate sump and discharged to the NRW line.

Figure 5-1 Map of Dairies in the Mini-grid Area

The RP-1 manure digestion system and operational experience is discussed in more detail in the Project 3.1 report.

Figure 5-2 provides a general illustration of the RP-1 process:

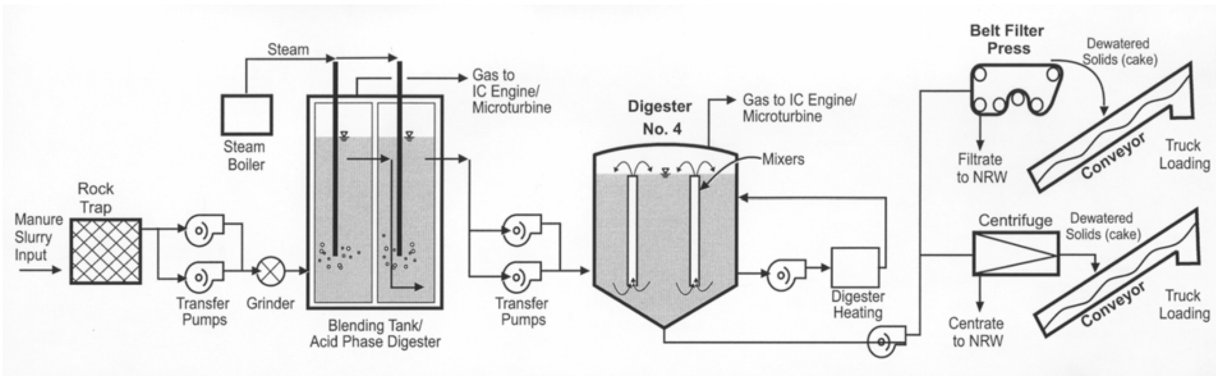

FIGURE 5-2
RP-1 Digestion Process Schematic

5.2 RP-5 Manure Digester

IEUA contracted with Synagro's Agribusiness Services Group to design, build, construct and operate a plug-flow anaerobic digester for dairy manure and the recovery of digester gas; this digester was placed in service in late 2001.

The manure is received in either liquid or dry form and unloaded into one of two slurry mix tanks prior to feeding into the digester. Water or dewatered centrate is added to the manure to adjust the manure slurry concentration. The slurry is then pumped continuously to the digester. The slurry flows in one end of a divided concrete trough, and then back up the other side. The hydraulic residence time (HRT) in the digester is between 18 and 20 days. No additional mixing is provided. A heat exchanger is used to heat the digester contents into the mesophilic range. The digester volume is approximately 1 million gallons; the slurry feed rate is approximately 50,000-55,000 gallons per day.

The digester biogas can be used to fuel four onsite microturbines to power the digester facility equipment or it is sent offsite to power a groundwater desalting facility. Currently, biogas is sent offsite to the desalting facility, where it is blended with biogas from RP-2 and used to run a 1,000-kW engine at the desalter. RP-2 and RP-5 typically provide approximately 1/2 of the energy needed to run the desalter engines with the balance being made up with natural gas.

Figure 5-2 (11x17)/1

Figure 5-2 (11x17)/2

The digested manure is dewatered to achieve a total solids (TS) content of approximately 25 percent. The dewatered cake is transported to IEUA's co-composting site. Centrate from the centrifuge dewatering is either added back into the slurry mixing tank at the front-end of the process or discharged into the brine Santa Ana Regional Interceptor (SARI) line for disposal.

The RP-5 manure digestion system and operational experience is discussed in more detail in the Project 3.1 report.

Figure 5-3 provides a general illustration of the process at the RP-5 facility:

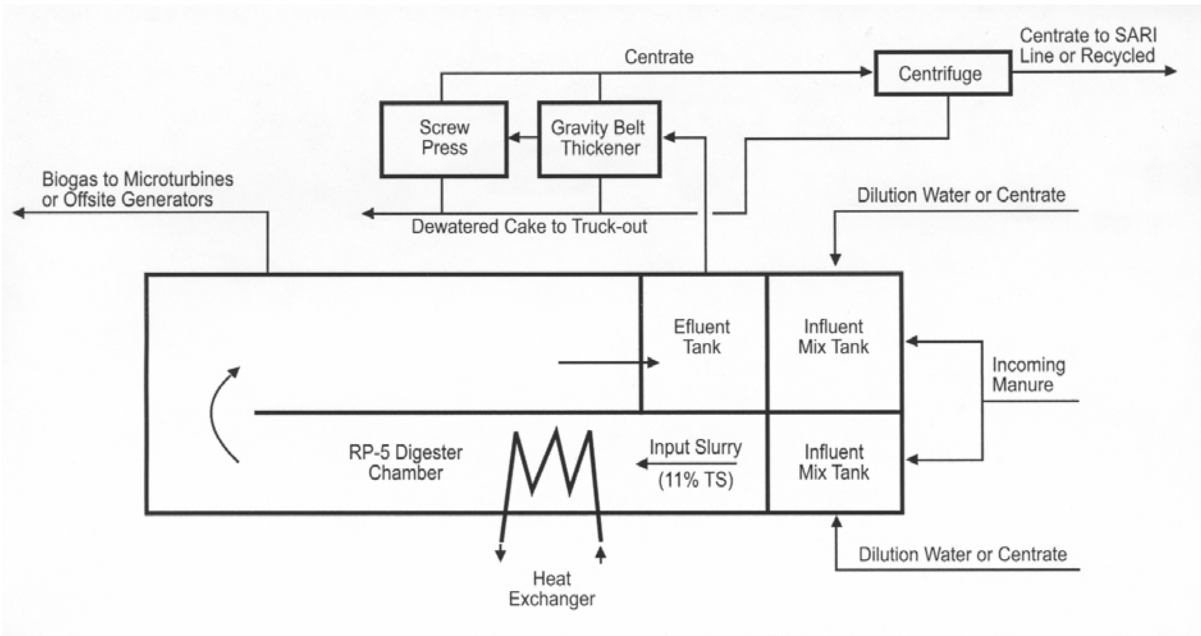

FIGURE 5-3
RP-5 Digestion Process Schematic

5.3 RP-1 and RP-5 for Dairy Waste to Energy

IEUA has also begun to test the advantages of co-digestion of manure with food processor waste to improve biogas production at RP-1and RP-5.

Projects which could be demonstrated at either or both locations include:

- Co-digestion of dairy manure with food processing waste
- Feedstock pretreatment
- Improved cellulose destruction
- Improved dewatering and waste liquid treatment
- Thermophilic digestion
- Improved gas cleaning
- Improved digester mixing

5.4 Corral-Dry Manure Gasification

A significant portion of the manure produced at the Chino Basin dairies is corral-dry manure, which is not appropriate for digestion. That said, corral-dry manure is a rich fuel (high BTU/lb) because of its low moisture content. However, the easily digestible organic matter has already been converted to methane and carbon dioxide while the manure was drying. What remains is largely cellulose, which neither the animal nor anaerobic bacteria can digest.

Corral-dry manure burns well because it is dry. Like any dry fuel, it can be burned in a boiler to make steam for power. The efficiency of this process is around 12 to 15 percent. However, biomass can be converted to a gas through gasification with about a 25 percent loss in its heating value. The gas can be run through a large gas turbine with 33 percent efficiency or a combined-cycle plant with up to 40 percent efficiency. Thus, even with the loss of heating value from gasification, the net efficiency of gasifying this matter and then burning the gas produced would be 25 to 30 percent. This is considerably better than the 12 to 15 percent from mass burning the material in a boiler. The result is about twice as much electricity from the same amount of fuel.

Gasification has the added advantage of allowing easier and more efficient management of emissions from combustion. In a mass-burn system, the entire exhaust must be treated in a stack, and emissions from burning manure may be especially problematic to treat. In gasification, the biogas from the process can be treated before it is burned. The result is a cleaner process with far less air emissions.

Gasification technology and system vendors will be discussed in more detail in a Project 3.1 report specifically addressing these issues.

A pilot scale demonstration project would be on the order of 15 MMBtu/hr. gas production. This would represent the processing of about 16 tons/hour (approximately 130,000 tons per year, 15 percent of the estimated 2001 Chino Basin production) of corral dry manure. The cost for this size pilot project would be $2 million to $4 million. Depending on the site-specific requirements, the costs could be higher.

The concentration of dairy cows in the Chino Basin is unusually high, for anywhere in the U.S. Because of this, the statewide applicability of manure gasification is somewhat limited. However, the projects would be of significant size and would address both a waste disposal issue and increase renewable energy production. A demonstration project would represent a significant commitment of the available funds for Project 3.1. Given the projected decline in the dairy industry in the Chino Basin, the waste disposal issue may eventually be resolved independent of any renewable resource efforts. There is less interest in the part of potential hosts in developing a manure gasification demonstration sites. Therefore, gasification of corral-dried manure has not been placed on the list of highest-priority biogas projects listed in the Executive Summary.

5.5 Burrtec Regional MRF Facility

The Burrtec Regional Materials Recovery Facility is a privately-owned and operated state-of-the-art municipal waste materials recovery facility located in the northeast part of the mini-grid. It has been previously evaluated as a potential site for a centralized manure digestion facility, independent of IEUA efforts, and was found to offer a potentially feasible location. The evaluation included consideration of possible funding assistance under programs administered by the USDA, which made up to $500,000 available for a project(s) for improving animal waste control.

The site location is some distance from the Chino Basin dairy clusters and does not have any existing infrastructure for the treatment of manure. New permits would be required to site a dairy manure treatment facility at this location.

This site is a potential location, but is less attractive than either RP-1 of RP-5, because they are located close to the existing dairies and have existing infrastructure for dairy manure digestion. The Burrtec site could be a site for a potential corral-dry manure gasification project.

Section 6

BI-PV Prioritization

This section provides the BI-PV site selection and project prioritization process along with a summary listing of recommendations for the highest ranked projects to be considered further under Project 3.3 of the Commonwealth Biogas/PV Mini-Grid Renewable Resource RD&D Program.

6.1 Background

The primary purpose of the pilot demonstrations under Project 3.3 of the Commonwealth Program is to validate ways in which building integrated PV systems can be developed and installed by ESPs, public entities, third parties, or building owners including approaches that can: 1) improve consumer affordability to these higher cost systems, 2) reduce installed PV costs per peak watt (and per life cycle kWh) and, 3) separately, find ways to add outside inherent value to the PV system installation over its life (i.e., through dual- or tri–use applications of the system). A discussion of the criteria used to select and prioritize potential pilot projects is included.

Building integrated photovoltaics (BI-PV) is a term that implies that a building or outdoor structure has photovoltaic cells incorporated into its exterior physical structure (i.e., roof, walls or shading structures) in accordance with applicable building codes and standards. Integration of these PV cells into the structure partially offsets the cost of other materials and potentially has other benefits such as reduced heat gain. BI-PV applications have been identified for new, renovation and retrofit projects. The BI-PV approach to PV deployment stands in contrast to other Building-Applied (BAPV) or Stand-Alone (SAPV) approaches, such as ground mounting PV in open spaces or attaching PV to buildings, in ways that limit the interaction between the PV system and other building elements. The BAPV and SAPV may have secondary benefits such as roof shading, covered parking structures, direct water pumping or combined solar-thermal-electric (STE) that provide additional benefits beyond the generation of electricity.

The penetration of BI-PV into buildings has been relatively minimal to date. Numerous market penetration barriers exist, including: high cost, low familiarity among building professionals, absence of net-metering tariffs, and challenges presented by the interdisciplinary nature of BI-PV projects (i.e., architectural, electrical, structural).

The BI-PV concept, its current state of development and its applicability to the PIER Program are described further in the January 2003 report entitled *PV Database, Siting Requirements & Mini-Grid Technical Potential Report*, submitted by RER and REDI as part of the PIER Program.

6.1.1 Site Selection Process

As with any type of solar energy generation facility, access to solar radiation is the primary requirement. The overall quality of the solar resource for an area may be expressed in terms of daily average "effective full-sun hours". The convention underlying this approach is that the energy intensity of the sun at mid-latitudes on the earth's surface corresponds to about 1,000 W/m 2 of incident solar radiation.

Full-sun hours values depend on the orientation of the surface upon which solar radiation is incident. For horizontal surfaces that are typical of many BI-PV applications, the Southern California solar resource is approximately 5 daily average full-sun hours. In contrast to some coastal and more northern areas of California the Commonwealth PIER mini-grid area has an excellent solar resource.

The climate, urban natural geography and terrain surrounding the Commonwealth Renewables mini-grid region also provide plenty of solar resource with adequate access for BI-PV systems. The natural geography is largely flat terrain and is composed of low growing vegetation, allowing for good solar access throughout the majority of the built environment. The urban geography of the surrounding cities contains primarily low-rise buildings. Many cities within the mini-grid area have ordinances forbidding buildings over 75 feet in height. Solar access issues that might arise from building shadows are less likely to occur within the mini-grid area than other urban population zones that may have high-rise buildings and tall vegetation.

The technical potential for non-residential photovoltaic applications within the mini-grid area was analyzed in Task 1.1.5 of Project 1.1. The technical potential was determined for both public and commercial facilities within the target area of the study. This was done separately for public and private sector facilities. The focus here in the prioritization task is on public facilities.

SIC codes, building types and zip codes were used to define the public agency facilities within the mini-grid area. A list of public agencies and facilities was created through a compilation of databases, including the phone book, American Business Lists, Special District Committee, Thomas Guide 2003, and the Local Government Commission. Estimates of the number of buildings and the amount of available building area were developed for all of the public facilities.

6.1.2 Decision Criteria Common to All Sites

An initial list of 240 potential BI-PV sites[1] was created under Task 1.1.5 of Project 1.1. This list is presented in Appendix A of this report. From this list of 10 sites will be selected as potential candidates for a large scale Public facility BI-PV demonstration project[2]. A list of potential ranking criteria for project staff follows:

- Construction (new construction or major renovation) and Timing
- Host/Developer Economics and Financing

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[1] Appendix A of the "PV Database, Siting Requirements
& Mini-Grid Technical Potential Report, Project No. 1.1 Program Planning and Analysis, Task 1.1.5 Final Report." Prepared by REDI and RER, for the California Energy Commission, January 2003.

[2] Project 3.3: Building Integrated Photovoltaics on Public Facilities Project.

- T&D Mini-Grid Impacts
- Minimum/Optimal Size Range
- Facility Interface Requirements
- Host Project Champion / Establishment of Direct Contact
- PIER Project Budget
- Program Linkages

Timing of Construction (for new construction/renovation projects only)

For facilities that have construction plans (new construction, renovation, or expansion) the timing of the construction is very important. The ability to introduce BI-PV into these plans depends on how far along they are. If the plans are just at the beginning and the scale of the project is sufficiently large it may not be possible to implement a BI-PV project and have it completed within the time limits of the PIER/Commonwealth Program. If the project is too far along, it may not be possible to introduce changes into the construction plans as these would cause delays and cost overruns for the construction.

Host/Developer Economics and Financing

Host support for a project is perhaps the single most important criterion. A supportive host will have a greater interest in contributing to the project financing and economics whether through matching funds or the labor and miscellaneous support needed for the project on a day-to-day basis. If technology vendors are willing to participate by providing equipment and testing and reduced costs, this allows the PIER project budgets to accomplish more work.

T&D Mini-Grid Impacts

The transmission and distribution (T&D) system as defined by the mini-grid will potential undergo several impacts due to the installation of BI-PV pilot projects. These include the reduction of system losses, deferral of transformer replacements and feeder installations, and system instability due to back feed during light load conditions.

Minimum/Optimal Size Range (>30 kW & <1 MW eligible for SGIP $)

The Building Integrated PV on Public Facilities Project will yield a set of specific photovoltaic facilities expected to range in size from 5 kW up to 1 MW, each addressing an infrastructure or commercialization barrier. This translates very roughly into approximately 750 to 150,000 square feet[3] of surface area, depending on site-specific factors. Thus achieving the PIER objective of demonstrating the potential for taking advantage of cost economies by installing relatively large PV systems with at least one under common ownership arrangements. The cumulative capacity of BI-PV systems expected to be procured and installed under this program element ranges from 30 to 3000 kW.

Facility Interface Requirements

The facility may require an electric utility grid interconnection for distributing excess electricity produced during light load conditions.

[3] Based on 150 sq.ft. per kW for crystalline silicon photovoltaic cells.

Project Champion/Host/Establishment of Direct Contact

For a project to be successful, it requires a host facility champion to carry it through the development/operations process. If there is not a person on the inside at host site taking charge and making it their job to make it happen, it is very unlikely that the project will succeed.

PIER Project Budget

The objective to reduce the installed cost of BI-PV on a cost per peak kW basis requires that the project budgets for all potential demonstration sites be determined. O&M costs need to be considered as well as these costs go directly the long term affordability of BI-PV.

Program Linkages

There may be opportunities to establish linkages to other PIER Renewable Programs, other projects within the Commonwealth Program or to the overall Commonwealth Program goals and objectives.

- PIER Renewable Programs – The other awarded Programs including those awarded to SMUD and Hetch Hetchy Water and Power, both of which have PV elements.
- Commonwealth Program Projects – The other Projects include Project 2.1, 2.2, 3.1, and 3.2.
- Commonwealth Program Goals – The applicable goals include:
  - Develop and implement an approach for tailoring resource development to the specific needs and resources of local areas, or mini-grids
  - Demonstrate the use of proper systems integration to enhance the performance of photovoltaic systems
  - Demonstrate the use of a basic rating system to improve the flow of information on photovoltaic system performance
  - Demonstrate the potential for taking advantage of cost economies by installing relatively large PV systems under common ownership arrangements

6.2 Selection of Sites for Future Consideration

If time and resources permitted, it would be possible to develop and evaluate all of the above-mentioned criteria for each of the 240 identified public facilities. Real project constraints exist making the prioritization process one of progressive elimination based on a sequential recruitment process.

The factors considered in ranking potential sites involved the following steps:

- Host Champion / Establishment of Direct Contact
- Construction (new construction or major renovation) and Timing
- Minimum/Optimal Size Range
- T&D Mini-Grid Impacts

- Program Linkages
- Host/Developer Economics and Financing

Establishment of Direct Contact/Host Champion

The identification of a host champion is directly linked to the process of identifying a direct contact for any given public facility.

The process of identifying direct contacts started with a direct mailing to all 240 public facilities by REDI. This direct mailing was an announcement of the PIER Public Facility BI-PV project (PIER/Commonwealth Project 3.3).

Subsequent to this, emails were sent to organizations representing public agencies (League of CA Cities/Local Government Commission/CA School District Association etc) with a public service announcement to include in their newsletters and emails. A description of the project was supplied and information was requested from these "multiplier" organizations.

Phone calls were conducted with school districts, cities, prisons, etc in an effort to identify new construction opportunities. Virtually all 240 facilities (many of the 200+ facilities are under one school district, city, or county contact) were called. Most of these calls were unsuccessful in generating a solid contact and very few persons returned calls even after repeatedly leaving messages.

After these efforts had been conducted, enough interest was generated to begin site surveys with willing clients - the prisons, community colleges, Navy facility, a couple of school district architects, and a county facility. On those first few site trips a map was generated with all of the BIPV client sites identified so that as various sites were visited a drive-by of some of the other locations could be performed to assess BI-PV potential.

While performing site visits, attempts were made to make appointments and on a few occasions cold calls were performed. The cold calls were conducted with the cities in particular. This effort generated contacts at several other potential BI-PV sites such as at the Chino Airport and the Ontario Police Department facility. The total number of sites actually "looked at", including drive-by’s, was approximately 35. These were mostly schools, city facilities (city hall, library, fire station, police department) and prisons.

A workshop for public sector facilities was held within the mini-grid. This was facilitated with the help of the local Assemblywoman and her staff as well as the local utilities (Southern California Edison and Southern California Gas Company). Advertising for the workshop outreach included direct mail and email to the list of 240 known public facilities, newspaper advertisements in the local newspapers, public service announcements on local radio and public television. The workshop was only lightly attended but it did manage to generate a couple additional interested contacts; in particular the Chino Valley YMCA.

Once at least 10 potential projects had been developed the focus was shifted to project development work. No additional efforts were made to identify contacts and recruit additional potential BI-PV sites within the mini-grid area.

Construction and Timing

For the sites where current construction plans existed, the timing of facility construction was determined. If construction was too far along, or was too early in the planning process to fit within the time constraints of Project 3.3, the site was dismissed from the prioritization process.

Minimum/Optimal Size Range

The size of a potential site can have an effect on what outside funding can be obtained (e.g., SGIP rebates) as well as the potential T&D impacts that can be realized. The California Public Utility Commission's Self Generation Incentive Program has project restrictions that only allow rebates for PV facilities greater than 30 kW and less than 1,000 kW (1 MW). The impact on the local mini-grid T&D system is partially controlled by the size of the BI-PV system as well.

T&D Mini-Grid Impacts

T&D impacts are a function of the location of the facility, the size and generation profile of the generation facility and how overloaded (or near to being overloaded) either the distribution circuit or the local substation serving that facility will be, considering all other known loads and generation connected to the local distribution system.

Host/Developer Economics and Financing

Owner funding needs are nearly always an issue – particularly in the public sector. It is likely that host owners identified for projects will require external project funding. Because of the permitting, installation and SGIP incentive receipt timeframes, many benefits to the owners from the project are delayed and long-term, while up-front investment costs are substantial and immediate. For projects to be economically viable, funding and financing assistance is necessary for at least one-half of the installed project costs. Currently Self-generation Incentive Program funds offering up to 50 percent of the project costs are available for projects in the 2003-04 and 2004-05 calendar years that fit the timeline of this contract.

Program Linkages

The linkages to other Commonwealth projects and program goals as well as linkages to other PIER Programs such as those sponsored by SMUD and Hetch Hetchy Water and Power are important elements to the overall PIER Program. The opportunity to establish linkages with other PIER Renewable Programs or other projects within the Commonwealth Program is also considered in the prioritization of potential sites.

6.3 Selected Sites

The site recruitment and prioritization process described above has resulted in 10 sites being identified as suitable for closer examination. Prioritization of Sites.

To prioritize the selected sites, a scoring system has been developed. This scoring examines the construction and timing, the minimum/optimal array size, the potential for mini-grid impacts, and program linkages. Each criterion is scored on a scale from one to three with one being the lowest ranking and three being the highest ranking. Each criterion is given a weight that reflects how importance it is relative to the Program objectives.

Construction is given the greatest weight since this reflects how closely the potential project conforms to the definition of building integrated. New construction projects are given the highest rating as they process the greatest opportunity for true building integration. Renovation projects are given the second highest rating. Renovations can be well integrated but may not be as fully integrated as systems designed to be integrated from the very beginning. Retrofits are given the lowest rating because renovations don't necessarily possess all the advantages of a truly integrated design. Of the three criterion available for prioritizing these projects, construction type has been given a relative weighting of 40 percent.

Array size is given the second largest weighting (30 percent) of the four prioritization criterion. In light of the California Public Utility Commission's Self Generation Rebate Program qualification requirements, those that exceed the size requirements are given a score of one. This lowest score is given because without outside funding, these large projects are less likely to be developed. BI-PV systems that are too small to qualify for this program are given a score of two. Even though they don't qualify, they are small and much easier to finance. Those projects that qualify are given a three.

The mini-grid substation is given the next lowest relative weighting (20 percent) of the four prioritization criterion. This has been done partly because the potential for T&D impacts is generally small with low penetrations of renewable self generation projects. Also, the impacts can be both positive and negative. Only a few substations within the mini-grid are overloaded or will be in the near future[4]. Substations C, D and G are heavily loaded and would benefit the most from the addition of distributed BI-PV generation. Those potential projects that are served by one of these substations are given a score of three. Two of the sites appear to be served by Substation D but may actually be served by Substation A. It is not clear which substation actually serves these but they have been given the benefit of the doubt for the prioritization scoring. Those that are outside of the mini-grid and not served by one of the substations examined in Project 1.1.9 are given a score of one. It is possible for sites to fall outside the mini-grid as the original database of public facilities was developed for the initial mini-grid study area which was later refined for the purposes of studying T&D impacts. All the remaining sites within the mini-grid are given a score of two.

Program linkages are given the least relative weighting (10%) of the four prioritization criterion. All sites have program linkages to some degree and in all cases except two, all the potential projects have been given a score of two.

Two of the sites stand out from the others with respect to program linkages. The first of these sites has the opportunity to capitalize on developments in the Sacramento Municipal Utility District's (SMUD) ReGen Program. Work involving systems for applying PV systems to new buildings under the "Photovoltaic" emphasis area have links to the this site. The potential site involves new construction with a roof top BI-PV array. This potential site has been given a program linkage score of three.

[4] See the report entitled "Development of Local Area Mini-Grid T&D Model," prepared by Regional Economic Research, Inc. and Zaininger Engineering, Inc., May 2003.

The other site involves a stand alone dual use STE system with the potential to become a triple-use application. This solar system is an interesting RD&D project with the opportunity to expand the technical potential of multi-use solar electric generation using a solar technology other than photovoltaic cells. In addition, this project has attracted the interest of third party developers which is one of the objectives for Project 3.3 of the Commonwealth Program. This project has technology links to Hetch Hetchy Water and Power's Public Renewables Partnership PIER Program and SMUD's ReGen Program. The "Concentrating Solar" emphasis area within the SMUD Program and HHW&P's "Developing Renewable Energy Technologies for Tomorrow's Electric System" emphasis area are linked to the technology at this site. This potential project has been given a score of three for program linkages.

Table 6-1 shows the scoring by criterion as well as the overall weighted score for each potential project. The projects have been sorted from highest overall score to lowest.

Table 6-1: BI-PV Project Prioritization

Site Name	Site Location	Construction & Timing (40%)			Min./Optimal Size (30%)			Mini-Grid T&D Impact (20%)			Program Linkages (10%)		Total Score
		Construction Type	Score	Wt'd Score	Array Size	Score	Wt'd Score	Substation	Score	Wt'd Score	Score	Wt'd Score	
Ontario School District	Ontario	BIPV-New	3	1.2	100	3	0.9	Outside	1	0.2	3	0.2	2.6
U.S. Navy Facility	Norco	SA-STE-New	3	1.2	1,000	3	0.9	Outside	1	0.2	3	0.3	2.6
CA Institute for Women	Chino	BIPV-Renovation	2	0.8	50	3	0.9	D	3	0.6	2	0.3	2.5
FEDCO	Ontario	BIPV-Renovation	2	0.8	40	3	0.9	D	3	0.6	2	0.1	2.5
IEUA - IKEA	Rancho Cucamonga	BIPV-Renovation	2	0.8	1,000	3	0.9	I	2	0.4	2	0.2	2.3
Civil Air Patrol	Chino	BAPV-Retrofit	1	0.4	5	2	0.6	D or A	3	0.6	2	0.2	1.8
Ranch View Elem. School	Mountain View	BAPV-Retrofit	1	0.4	15	2	0.6	D	3	0.6	2	0.2	1.8
SB Co. Maintenance	Chino	BIPV-Retrofit	1	0.4	3.5	2	0.6	D or A	3	0.6	2	0.2	1.8
Riverside Comm. College	Norco	BIPV-Retrofit	1	0.4	33	3	0.9	Outside	1	0.2	2	0.2	1.7
YMCA	Chino Valley	BIPV-Retrofit	1	0.4	10	2	0.6	A	2	0.4	2	0.3	1.6

The issue at this stage that will have a significant outcome on which projects are selected for development under the Commonwealth Program is the availability of project financing. Even though these prioritized projects have host champions, if the financing can't be arranged for the remaining project funds the project will not come to fruition. The final selection of sites for Project 3.3 will involve the development of BI-PV engineering assessments and the determination of financial and environment costs and benefits for each of these potential sites and the securing of project financing.